JULY, AUGUST 1961

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A MAGAZINE DEVOTED TO THE INTERESTS OF RADIO, HI-FI AND TV TECHNICIANS IN CANADA

ROGERS BOOSTER

cover story

The small businessman has an ideal opportunity to play a satisfying role in his community. By supplying good service he can establish a reputation for his work. He can become known personally to his customers and, by studying the development of the needs of his area, he has a good chance to expand his business.

Arsene Fortin, of A. Fortin Radio Service, 47 Fleury Street, Montreal, is a service technician who started with $500 capital, established a sound business, and has since expanded into ancillary fields.

After graduating from the Canadian School of Electricity and the National Radio Institute, Mr. Fortin worked for seven years as a service man for another company. In 1949, he set up his own business. Today, he sells radios, TV sets, stereo machines and records as well as offering complete servicing facilities.

He employs six service men and operates six trucks, covering the Ahuntsic areas of Montreal.

A 90-day guarantee is given on bench work, including labor. If parts, other than the ones replaced on the original service call, need replacement within the 90-day guarantee period, the labor is free. Charge is made only for the new parts.

In 1959, Mr. Fortin formed a subsidiary company called Ahuntsic Telecommunications, which is a cable system for U.S. Television channels plus FM music in co-operation with a local radio station. Today, more than 2,000 customers use this system.

Mr. Fortin has shown that, with professional training and sound business management, a good reputation can be established in a community — and this lead to progress and profit.

Inverters

An inverter is a device for converting direct to alternating current. Any oscillator operating from a d-c supply is an inverter although it is not always referred to as such. In industrial power circuits we usually start off with an alternating voltage generated by rotating machinery. This may be collected from slip rings and so remains a.c. Or, it may pass through a commutator or other form of rectifier and become d.c. Thereafter, certain applications may require that this supply be changed again to alternating current and the device that produces this change is called an inverter. (Of course, the supply need not have originally been a.c. because an inverter may operate from batteries in some applications). For low frequencies and large power requirements, devices such as the thyratron, the ignitron and the mercury arc rectifier are used in inverter circuits, their function being to commutate or perform the switching operation. Whatever device is used, it must have grid control and some inductance or capacitance (or both) must be present to provide storage capacity.

One simple inverter circuit is shown in Figure 1. In this example the resistance R1 is relatively high and R2 is relatively low. Before the switch is closed, the anode, grid and cathode of the thyratron are at the same potential and capacitor C is uncharged. When S is closed, the grid is made positive in relation to the cathode and, if the direct voltage is higher than the ionization potential, the thyratron will fire and current will flow through L, R2 and through C and R1 in parallel. R1 being large, the capacitor will charge quickly and the potential of the cathode e_c will

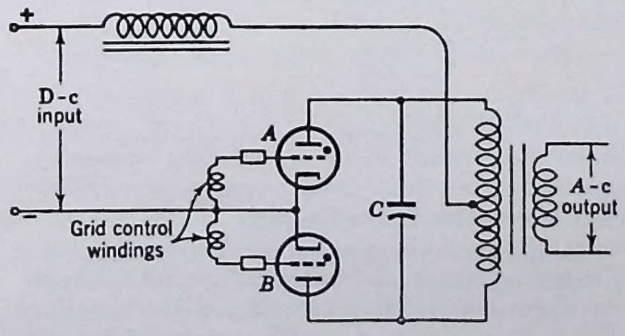


Fig. 1

rise as shown in (b). The potential rise of the cathode will tend to reduce the voltage across the cathode-anode circuit below the ionization point. Simultaneously, the inductance L will tend to maintain the current for reasons that are already well know. Because of this, C will continue to charge and the voltage across it will become greater than the applied voltage. When all the energy stored in the core of L is expended, the voltage across the thyratron falls and leaves the potential of the cathode higher than the anode or grid potentials. Current through the thyratron then ceases and deionization occurs.

Meanwhile, the capacitor discharges through R1 and, as the discharge continues, its potential and that of the cathode drop to the point where the anode-cathode potential reaches the ionization point again. The thyratron then fires and the cycle is repeated. The time of firing, and therefore the resulting frequency of oscillation, can be varied by the position of X on the potenti-

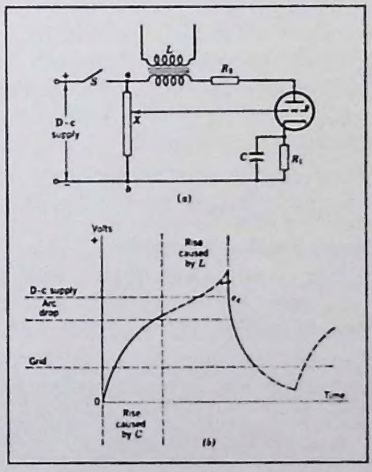


Fig. 2

ometer a-b which controls the grid bias. Variations in the values of R1 or C will also affect the frequency.

The thyratron current flowing through a transformer will cause the latter to deliver on alternating current to a suitable load although the waveform will not be sinusoidal.

In the foregoing example the frequency of the output is adjustable but in most power inverters the frequency is determined by a separate source. The circuit of a simple single-phase inverter, using two thyratrons, is shown in Figure 2. The thyratron grids are controlled by a separate voltage source and are connected in

Let us assume that the grid supply at the moment of starting is positive for A and negative for B so that tube A fires and electrons flow a balanced circuit wherein both anodes are connected to the positive side of the d-c supply. from the negative d-c line through the upper half of the transformer primary to the positive side of the line. The surge of current through the winding creates a reactive drop (IX) which reduces the potential on the anode of tube A to the arc-drop voltage. The capacitor becomes charged to a voltage of E_{dc}-arc drop with its upper side negative and its lower side positive.

When the grid control voltage reverses, making A negative and B positive, a rapid action occurs. The negative grid of A does not affect tube conduction but the positive grid of B causes it to fire and the surge of current through the lower half of the winding reduces the potential of anode B. At the same time, electrons flow into the lower positive side of capacitor C which permits electrons to flow out of the top side and reduce the potential of anode A. This allows the grid of A, which is now negative, to regain control. At the end of the half cycle, a reverse action occurs, tube A conducting and tube B being cut off. We see then that the two tubes act as a reversing switch to cause alternate pulses of current through the primary of the transformer and the resulting reversals in magnetization of the core induce an a-c output in the secondary. The frequency of the secondary voltage will be the same as that applied to the grids.

A Typical Low-Power Inverter

The circuit is shown in Figure 3 and its operation is as follows: When switch S is closed, a current passes through R2 and through the filaments of the thyratrons. As soon as the thyratrons are heated up the bi-metal relay Rel1 closes the contact so that direct current flows between the centre tap of the transformer primary via choke L to the positive side of the d-c line. Both ends of the primary winding are connected to the negative side of the line through a thyratron. To produce an alternating current, the direct current must flow alternately through the left and right sections of the primary so that an alternating voltage is induced in the secondary windings. The necessary switching action is effected by the control grids of the thyratrons. When one thyratron is ignited, the other is extinguished by means of the commutating capacitor C1 which interconnects the two anodes. In this circuit the thyratron is extinguished owing to the anode voltage of the relevant tube dropping briefly below the arc voltage.

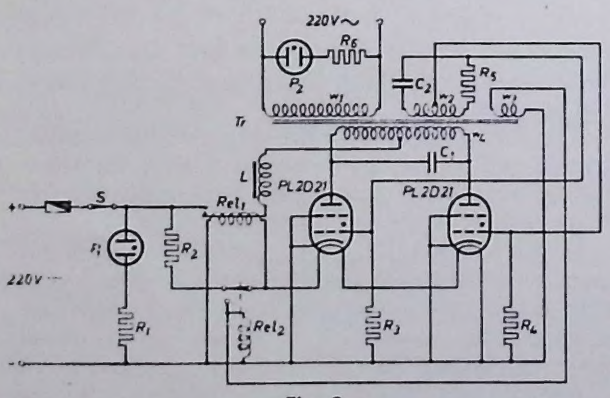


Fig. 3

The frequency of the alternating voltage produced depends upon the frequency of the voltage applied to the grid which, owing to the coupling between the grid and anode circuits, is in turn determined by the frequency in the anode circuit. For this purpose the transformer is equipped with an extra winding W2 which, together with C2 and R5, constitutes a phase-shifting network. Since, to obtain self-excitation, the phase angle between the anode voltage and the grid voltage should have a certain value, the frequency is determined by the constants of the RC network.

Variation of the resistance causes variation of frequency. On the other hand, the shape of the alternating voltage produced and the effective output are determined by the constants of the anode circuit, the value of the commutating capacitor being of particular importance.

The moment the inverter starts working and a voltage is excited in the secondary winding W1, a voltage is induced in the winding W3, as a result of which relay Rel2 is then interrupted and the filament current supply is taken over by winding W3. This prevents unnecessary loss of energy in resistor R2.

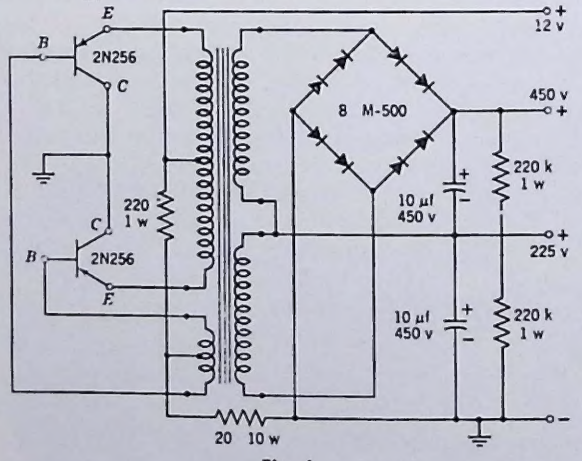


Fig. 4

The Transistor Power Supply

Transistors may also be used to perform the switching action and a typical circuit is shown in Figure 4. In this circuit a 12-volt battery

(continued on page 6)

Typical Mobile Equipment

Part 2

In our previous issue we gave a general description of the Rogers-Majestic Mobilophone and some specific data on the receiver section. Included with the last issue was a complete circuit diagram which the reader should have in front of him now because it is essential for the discussion to follow.

The Transmitter

This section uses nine vacuum tubes, four of which are dual-purpose so that the effective number of tubes is thirteen. The crystal oscillator operates at 1/24th of the desired frequency and feeds into a triode phase modulator. A relay is used to select either one of two crystals so that two-channel operation is obtained. Each crystal has its own vernier capacitor to provide precise adjustment of the oscillator frequency and the bandwidth of the tuned circuits in the transmitter is such that practically no deterioration in performance occurs if the channels are spaced not more than 500 kc apart.

The modulation limiter comprises a pre-emphasis circuit and a symmetrical diode clipper. The latter is followed by a de-emphasis circuit. The overall effect of the two networks is to produce a flat frequency response when operating below the clipping level. Note however that, by applying high frequency pre-emphasis before clipping, modulation limiting is applied chiefly to the higher frequency a-f components. In a phase modulation system, the latter are largely responsible for frequency excursions beyond the rated maximum.

The clipper is designed for symmetrical clipping of both polarities of the input waveform and it produces very little waveform distortion until the clipping level is reached. The setting of the peak modulation control fixes the maximum possible frequency modulation.

The modulator is followed by an amplifier and three multiplier stages, these three being a quadrupler, a tripler and a doubler. The doubler is followed by two driver stages operating at the output frequency and feeding the power amplifier which has a rated output of 30 watts.

The power amplifier is a balanced tetrode, the 5894A, which has a hard glass envelope and sintered glass seals. It is these features that permit operation at high ambient temperatures and at high levels of mechanical vibration. Fixed bias and good regulation of screen voltage make consistent performance possible when tubes are changed in the field and also protect the power amplifier tube in the case of drive failure.

for technicians

Handy Mirror for TV House Calls — The illustration shows how I modified my tube caddy so that I always have a mirror handy when on house calls. The mirror should be of such a size that a one-inch space is left on one side of the flap covering the larger size tube compartment.

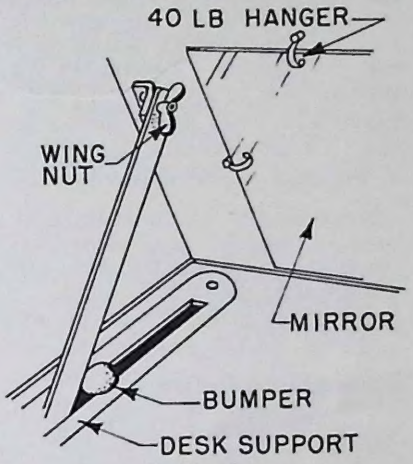


Fig. 1

The glass is fastened to the flap with four 40-lb. picture hangers bent to fit. The lid is held open and adjusted for position by a Hahn Brass Desk Support (hardware store) and a G.C. 7597-C ¼" rubber bumper button. The support is mounted at one end of the compartment with 6-32 nuts and bolts and is attached to the flap with two 6-32 bolts and one 6-32 wing nut. After use, the lid can be closed by removing the wing nut and disconnecting the support.

A. Fulmore
Edmonton, Alta.

●

Hum Filter for Bench Testing — Twelve-volt battery eliminators are commonly used when testing transistor car radios on the bench. A hum filter is a must and I constructed one very quickly and inexpensively from parts in my junk box. All that is required is two old speaker fields from 6-volt car radios and two 4000 mfd 50-volt capacitors. The accompanying illustration tells the rest of the story.

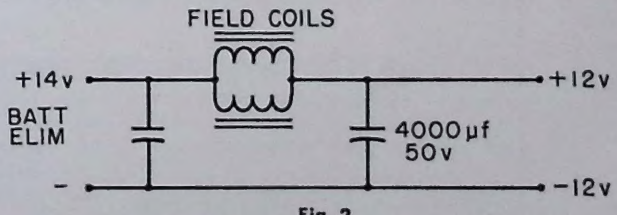


Fig 2

Andy Maxim
Niagara Falls, Ont.

A two-section constant K harmonic filter between the P.A. and antenna holds the harmonics down to the level called for in the specifications. Also note that the antenna relay coil operates from the bias supply line.

The Transistorized Power Supply

The unit is intended to operate from a 12-volt d-c source and supply the following voltages to the transmitter: +540 volts dc at 130 ma, +270 volts dc at 90 ma and —50 volts dc bias. To the receiver it supplies 300 volts dc at 45 ma and +150 volts dc at 65 ma.

Since a step up in voltage is required, transformers must be used which means that the d-c supply must first be converted to ac. Thus the first section of the power unit could be classified as an inverter.

General Description

The incoming dc is converted to an alternating voltage of from 1500 to 2000 cycles-per-second by means of the push-pull transistor switching circuit and this voltage is stepped up by a ferrite-cored transformer with three secondary windings. The three secondary voltages are then rectified by silicon rectifiers and filtered.

The power unit also contains a receive-transmit relay K104. When switched to the transmit position the 300-volt section has a 250-volt section connected in series with it to provide the maximum voltage required by the transmitter.

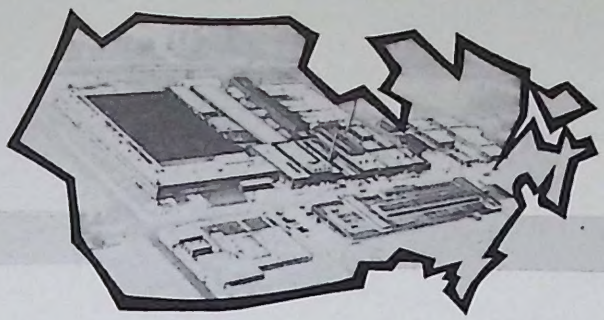
Inverters *(continued from page 4)*

supplies d.c. to operate an inverter consisting of two transistors and a transformer. The transistors operate as switches in the d-c primary circuit and allow current to flow through the transformer, first through one half of the primary and then through the other half. The function of this power supply is to furnish a high direct voltage from a low-voltage storage battery and so the alternating voltage induced in the transformer secondary is rectified by the silicon diodes in the bridge rectifier circuit.

ROGERS NUTDRIVER PROMOTION OFFER

ENDS SEPTEMBER 15, 1961

The current Rogers promotion offer of an Xcelite Nutdriver tool set will officially end on September 15, 1961. All submissions of 200 Rogers receiving tube "pin connection" end flaps postmarked on or before that date will be honoured. Don't be disappointed—make sure you mail yours in time.



industry news

BBG Activities

Applications to set up eight satellite stations have been made by CFCR-TV Kamloops, B.C. . . . CHCH-TV Hamilton will seek to cut its tie as a CBC affiliate . . . Also scheduled for hearing are applications for five new TV stations, twelve new AM radio stations and two new FM stations . . . Applications for new TV stations include Quebec City on Channel 11, Peace River, Alta., Grande Prairie, Alta. (one CBC and one independent) and Dryden, Ontario on Channel 9 . . . Satellite applications include Ashcroft, Chase, Clinton, Lillooet, Merrit, Mount Timothy linked with Kamloops, B.C.; Parry Sound, Ont. linked with CKVR-TV; Port Alfred, Que. linked with CKRS-TV; Peace River, Alta. linked with proposed new station at Grande Prairie; and Sioux Lookout, Ont., linked with proposed new station at Dryden.

It Never Rains But It Pours

The Japanese Ministry of International Trade and Industry, which establishes prices on radios and other electronic equipment exported by Japanese manufacturers, is reported to be ready to announce a reduction in the price of transistor radio receivers for the export market. Some sources here indicate that MITI is ready to set a check price of between $6 and $7 for six-transistor single-band radio receivers. Heretofore, the check price was $11 for such receivers.

Discontinue Receiving Tubes

Philco Corp. and CBS Inc. in the U.S. are dropping out of the receiving tube market. Philco will gradually discontinue receiving tube operations during the rest of this year while CBS stopped production June 30.

The D.O.T. Will Like This

Matsushita Electrical Industrial Co., Ltd., is attempting to develop a television set for installation on automobiles by the end of the year, an engineer of the firm said. Some other television set manufacturers are also conducting development work on automobile TV sets, it was reported by industry sources.

The FCC Gets Tough

The Federal Communications Commission has for the first time in its history ordered two TV set owners in Maysville, W. Va., to show cause why they should not cease and desist from causing interference to a shut-in's radio reception and to appear at a hearing there on July 12. The commission has taken action against users of electronic equipment which disrupts radio communications on many occasions but has never before resorted to formal proceedings against a private set owner.

New Color Tube

A CRT for color television said to operate at 20,000v with the same brightness as a black-and-white unit was demonstrated at the annual meeting of Paramount Pictures Corp. in New York. The tube, which was developed by Autometric Corp., Paramount's subsidiary, is a modified version of the firm's Chromatron tube introduced several years ago.

Dissension In The Ranks

Some friction has been reported over the activities of the Electronic Industries Association. One prominent manufacturer has withdrawn from the receiver section of the organization because, according to the president, it got no backing from other related industries on a proposal to get duty-free importation of color picture tubes. Furthermore, it disagreed with a motion that would eliminate statements of sales position sent to member firms on request . . . EIA figures show TV sales to dealers have dropped 6.7 percent for the first five months of 1961. However, the total of 109,172 does not include the April-May figures for the withdrawing company . . . TV production in the U.S. in the week ending June 23 increased to 137,655 from the preceding week's total of 131,765. Radio output was up to 350,684 from 339,468 a week earlier while production of car radios fell to 110,338 from 117,246.

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what's NEW?

in semi-conductors, tubes and components

T.V. Picture Tubes: Conventional Vs Low G2 Types

The desirable features sought in T.V. picture tubes include sharp focus over the whole screen area, a line width that essentially does not thicken with increasing brightness and a minimum drive voltage. The effort to improve picture tubes in these or other areas is continual.

One relatively new type of picture tube requiring less drive voltage than the conventional tube is the low G2 type. This refers to the low G2 voltage (around 50 volts) required for this tube compared to the voltages of 300 to 500 volts usually required in a picture tube. For this discussion, picture tube type 23CP4 represents the conventional tube and type 23EP4 the low G2 tube.

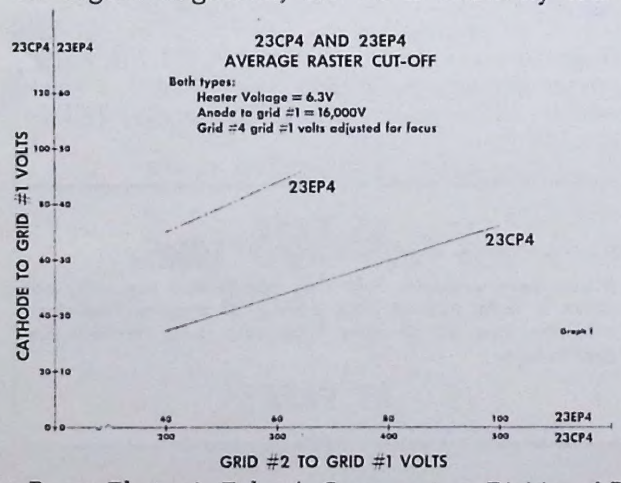
First, let us note the change that has taken place over the years in the method of driving the picture tube. Earlier T.V. sets had the video signal applied to the picture tube grid, with the cathode either going to ground or connected to a brightness-control potentiometer. The common practice today is to apply the video signal to the picture tube cathode. Among other reasons, this was done because less drive is required for the same highlight brightness as can be seen from the 23CP4 curves in graph 2. From the graph you can see that for a G2 voltage of 500 volts and 200 foot lamberts brightness, the cathode drive curve (labelled Eg2-G_1=500 volts) only about 63 volts are needed compared with 75 volts for the grid curve (labelled Eg2-K=500 V) Thus, for the same tube and the same brightness, cathode drive operation needs less drive. This is to be expected since with G1 drive the G2-to-cathode voltage remains unchanged. But since cathode drive lowers the cathode voltage for higher brightness, the G1 is relatively less negative and also the G2-to-cathode voltage is raised thus adding to the increase in brightness.

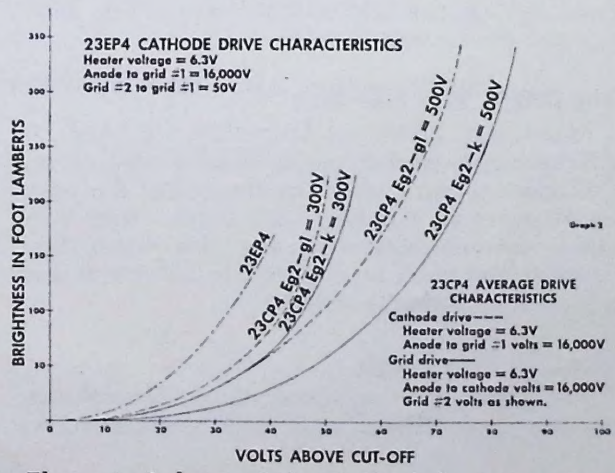
A conventional picture tube can be operated at any G2 voltage within specified limits. In fact, raising the G2 voltage improves the focus and also raises the raster cut off voltage as shown in graph 1. Assuming that sufficient video drive signal is available, the raising of the G2 voltage also permits an increase in highlight brightness. This is shown by the 23CP4 curves of graph 2. This graph also shows that by raising the G2 voltage, ie from 300 to 500 volts, a greater video signal is needed for the same brightness. This is a definite disadvantage as more gain is needed from the T.V. receiver.

It is also possible to reduce the required video signal amplitude by lowering the G2 voltage. Because the electron gun in conventional tubes is not designed for low G2 operation, this produces poor focus. Specially designed guns, as in the 23EP4, have minimized this defocussing. The maximum obtainable brightness of the 23EP4, as shown in graph 2, is much less than that of the 23CP4. Also the 23CP4 maximum brightness rises with the Eg2 voltage.

It would be very unwise to forecast that the low G2 tube type will, with time, replace the conventional tube type. One major U.S. set maker has been using it for some years and was recently joined by a second major U.S. set maker along with its Canadian associate.

The low G2 tube type will probably become predominant if the trend to truly portable T.V. receivers gain momentum. This is because of its higher drive sensitivity needed to match the transistors' low output voltage.




23EP4 CATHODE DRIVE CHARACTERISTICS
Heater voltage = 6.3V
Anode to grid #1 = 16,000V
Grid #2 to grid #1 = 50V
BRIGHTNESS IN FOOT LAMBERTS
23EP4
23CP4 Eg2-g1 = 300V
23CP4 Eg2-k = 300V
23CP4 Eg2-g1 = 500V
23CP4 Eg2-k = 500V
23CP4 AVERAGE DRIVE CHARACTERISTICS
Cathode drive
Heater voltage = 6.3V
Anode to grid #1 volts = 16,000V
Grid drive
Heater voltage = 6.3V
Anode to cathode volts = 16,000V
Grid #2 volts as shown.
VOLTS ABOVE CUT-OFF

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